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AUTOMATIC PIBAL TRACKING SYSTEM

By
Willie N. Jacobs

ATMOSPHERIC SCIENCES LABORATORY
WHITE SANDS MISSILE RANGE, NEW MEXICO

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ABSTRACT

An Automatic Pibal Tracking System has been developed utilizing a T-9 Radar for the tracker. This system provides an efficient means of acquiring wind information to 10,000 feet altitude with an accuracy compatible with Missile Range requirements. By eliminating manual tracking and calculations, a significant reduction in operating personnel is achieved.

CONTENTS

INTRODUCTION

Meteorological research and missile range support activities have placed a premium on more accurate, reliable, and timely means of acquiring and presenting wind data. Of primary concern at White Sands Missile Range is the atmosphere layer within 4500 feet mean sea level (MSL) and 14000 feet MSL. Measurements under consideration are east-west (X) coordinate, north-south (Y) coordinate, and height (Z) coordinate of the balloon position, and the corresponding wind velocity components at specific increments of time during a pilot balloon (pibal) flight.

Meteorological research and wide-spread range facilities dictate the need for a pibal tracking system to cover all sites and terrain for comprehensive studies of environmental conditions.

DISCUSSION

Development of the Automatic Pibal Tracking System (APTS) was initiated in February 1964. The T-9 Radar of the Skysweeper System was selected as the radar to be used because of its low radiated (40 KW Peak) power output and slant range capabilities (26000 yards). The radar is also small in size, measuring only 42 inches in width, 75 inches in length and 50 inches in height.

The first pibal sounding with the T-9 Radar was conducted at White Sands Missile Range in March 1964. A 100 gram balloon was flown with a small radar target (corner reflector) attached. The balloon was moved approximately 100 yards away from the radar and extended on a string to a height of approximately 100 feet. The radar was aligned on the target by using the radar's optics and by observing the "J" scope. The balloon was released and successfully tracked to the desired height (10,000 feet) at which time the flight was terminated. After several successful pibal soundings a comprehensive system design was initiated.

The first operational system (Figure 1) was installed in May 1964. The tracking radar was installed approximately 3000 feet from the Blockhouse, with radar control remoted to a console inside the Blockhouse. The radar tracking data (azimuth, elevation, and slant range) were transmitted into the remote control console via two speed servo loops. To provide optical tracking for the operator, a closed circuit television system was installed. The camera was bracket mounted on the radar dish and oriented along the axis of

the dish. The television monitor was mounted in the control console in a position which the operator could observe while manually tracking. An "A" Scope was also mounted in the control console to display radar targets.

The desired analog output from the APTS is "X" and "Y" velocities vs height. To provide this output a small analog computer was designed and installed in the remote control console and two 11 x 14 inches "X" and "Y" plotters were used to display velocity vs height as the pibal was in progress.

After conducting approximately 100 pibal soundings, the Automatic Pibal Tracking System was installed in a position parallel with an operational manual double theodolite system and its associated analog computer. The purpose of this parallel installation was to obtain comparative data while both systems tracked the same balloon (with a radar target attached) for wind profile comparisons. The results of the wind profile comparisons are published in ECOM Report #5121, "Comparative Evaluation of the Automatic Tracking Pilot Balloon Wind Measuring System," by Stanley F. Kubinski, April 1967.

These comparisons showed that the APTS provides an accurate and reliable means of acquiring wind profiles, so fabrication of other systems was started. Two types of mobile systems were fabricated. A mobile system (Figure 2) was fabricated using a K-78 trailer to house the operation center. The T-9 Radar was mounted on the trailer elevator so that the elevator could be raised for operation and lowered for traveling. The second type of mobile system (Figure 3 and 4) fabricated employed a 2 1/2 ton stake bed truck as a mount for the T-9 Radar and power generator. The truck was equipped with jacks for leveling the radar when in operation. A four wheel van was used to provide an operation center which could be towed by the radar truck when moving to a new position. In the fixed station system, (Figure 5 and 6) the radar is installed approximately 1,000 feet from the Blockhouse on an elevated pad. The remote control console is installed in the Blockhouse. In some of the systems where a digital output is desired, a 13 bit Optical Digital Encoder is mounted on the servo receivers (azimuth, elevation and slant range) to provide the digital output. The digital output is transmitted into a digital computer or recorded on magnetic tape for use at a later date.

CONCLUSIONS

The Automatic Pibal Tracking System provides wind profiles while reducing the number of operating personnel required. By providing

automatic tracking and automatic data reduction, only one person is required to conduct a sounding, while the manual system requires a minimum of six (6) people. The APTS provides the same accuracy on each pibal and is capable of tracking through fog, clouds and experiences no difficulty when pointing at the sun. Comparison tests of the Automatic Pibal Tracking System and an operational double theodolite system equipped with an analog computer have produced comparable wind profiles. In addition, the tests demonstrated definite advantages of automatic tracking over manual theodolite tracking. In particular the radar tracker proved especially superior where wind shears create triangulation problems with the double theodolite system.

The Automatic Pibal Tracking Systems have successfully tracked approximately 1500 pibals over the past two years at WSMR. Approximately 1000 of the 1500 pibals were conducted to provide wind profiles for impact prediction of unguided missiles, the other 500 pibals were conducted for R and D studies.

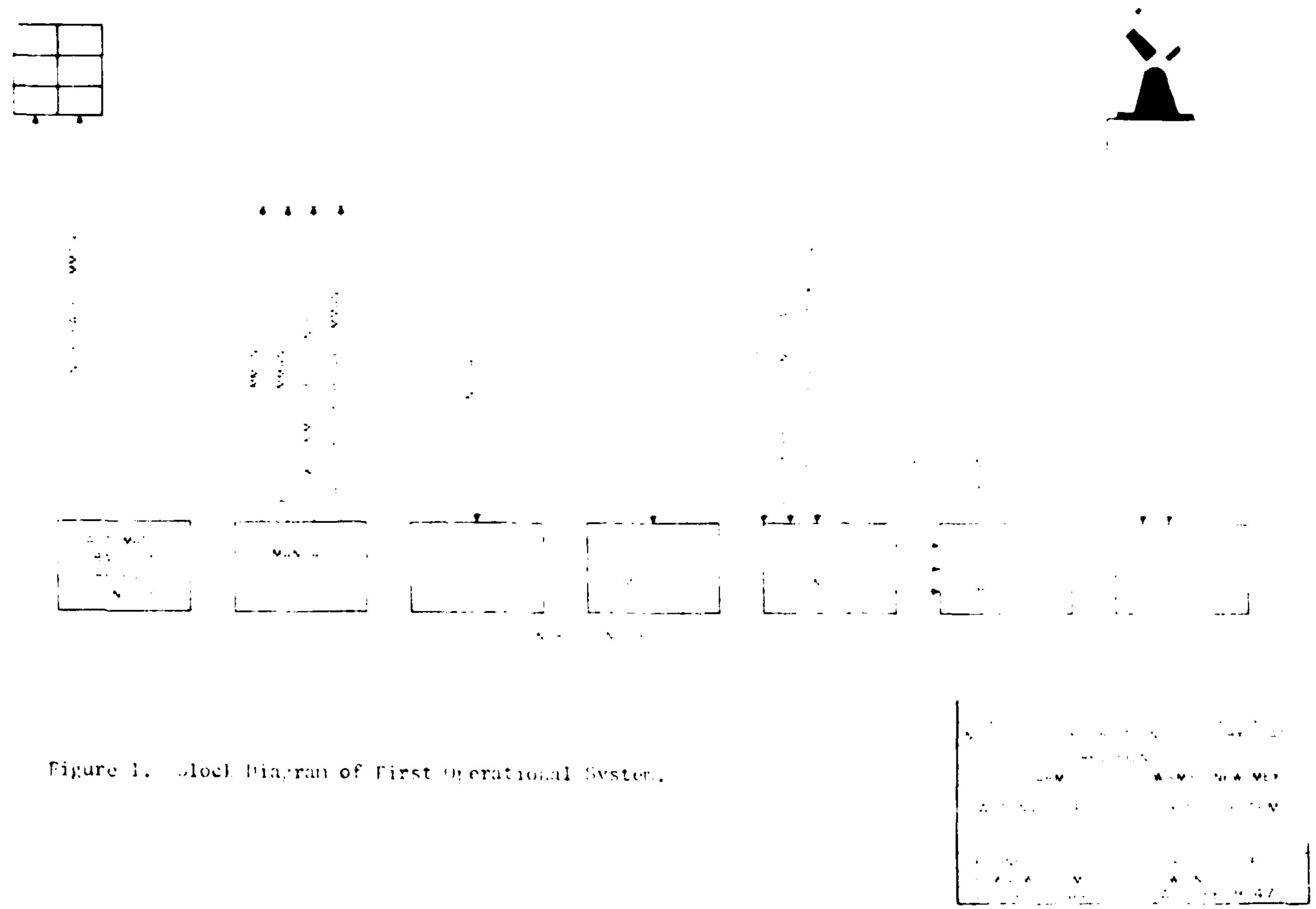

Figure 1. Block Diagram of First Operational System.

Figure 2. Mobile System Utilizing K-78 Trailer to House the Operation Center.

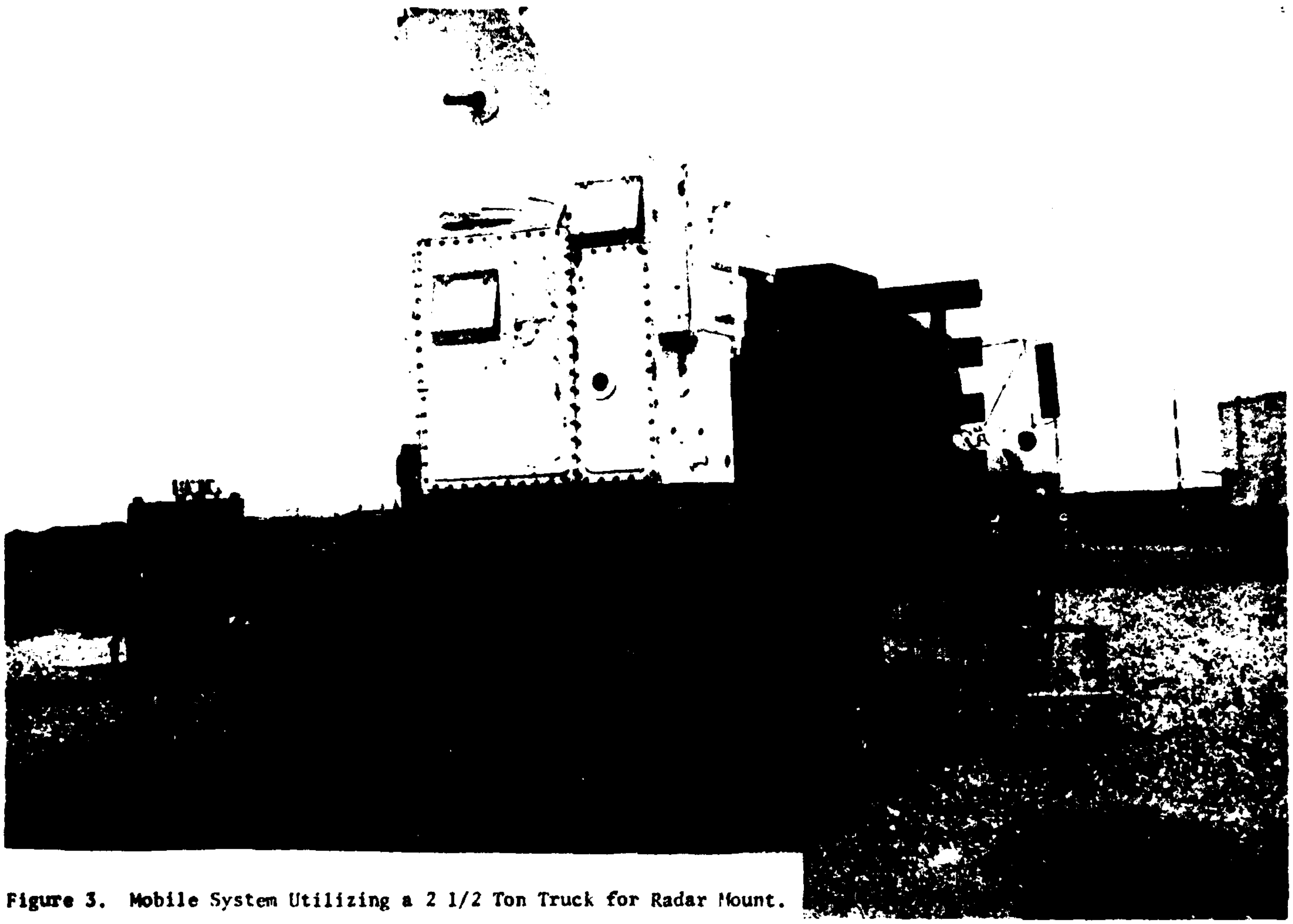

Figure 3. Mobile System Utilizing a 2 1/2 Ton Truck for Radar Mount.

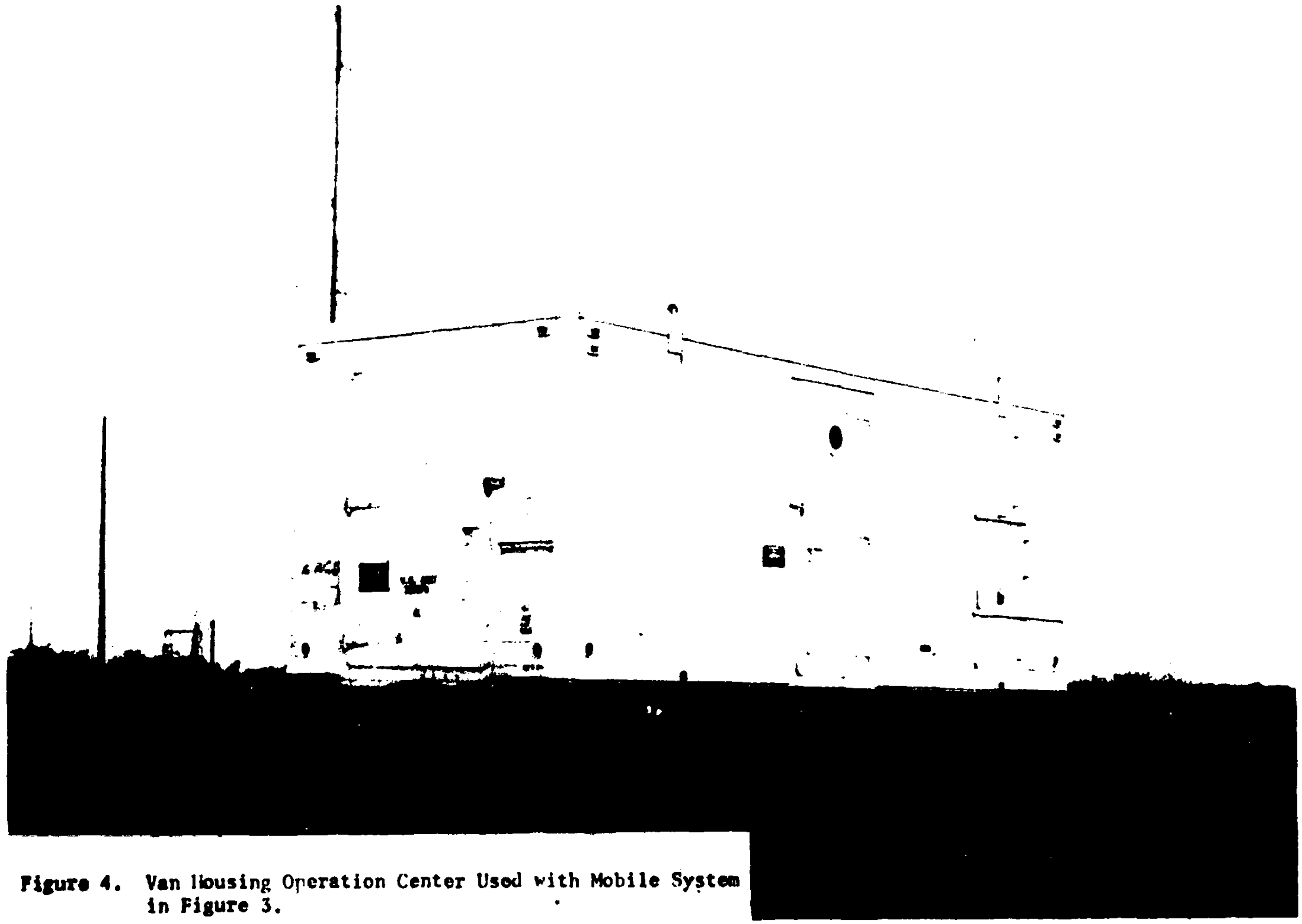

Figure 4. Van Housing Operation Center Used with Mobile System in Figure 3.

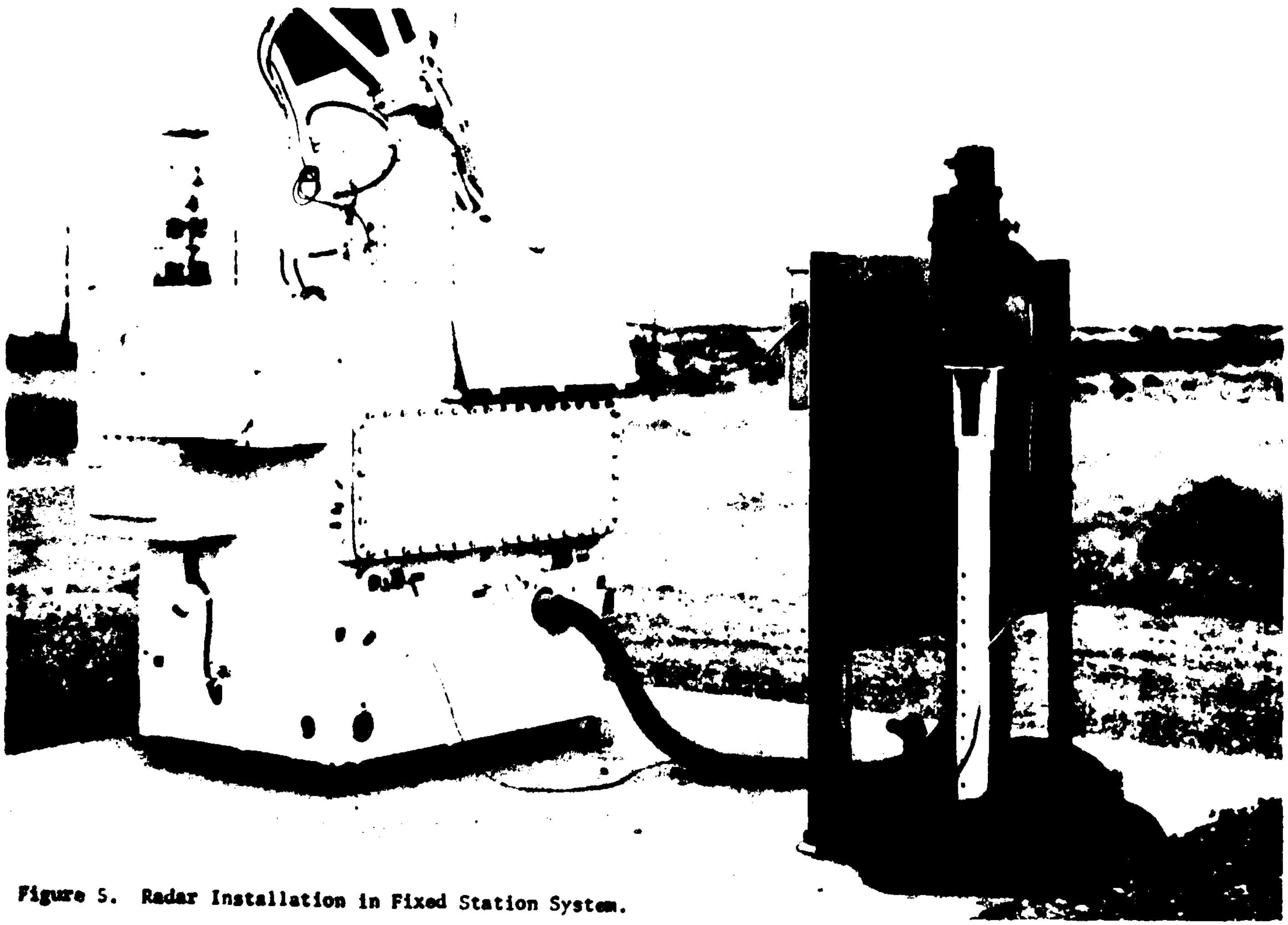

Figure 5. Radar Installation in Fixed Station System.

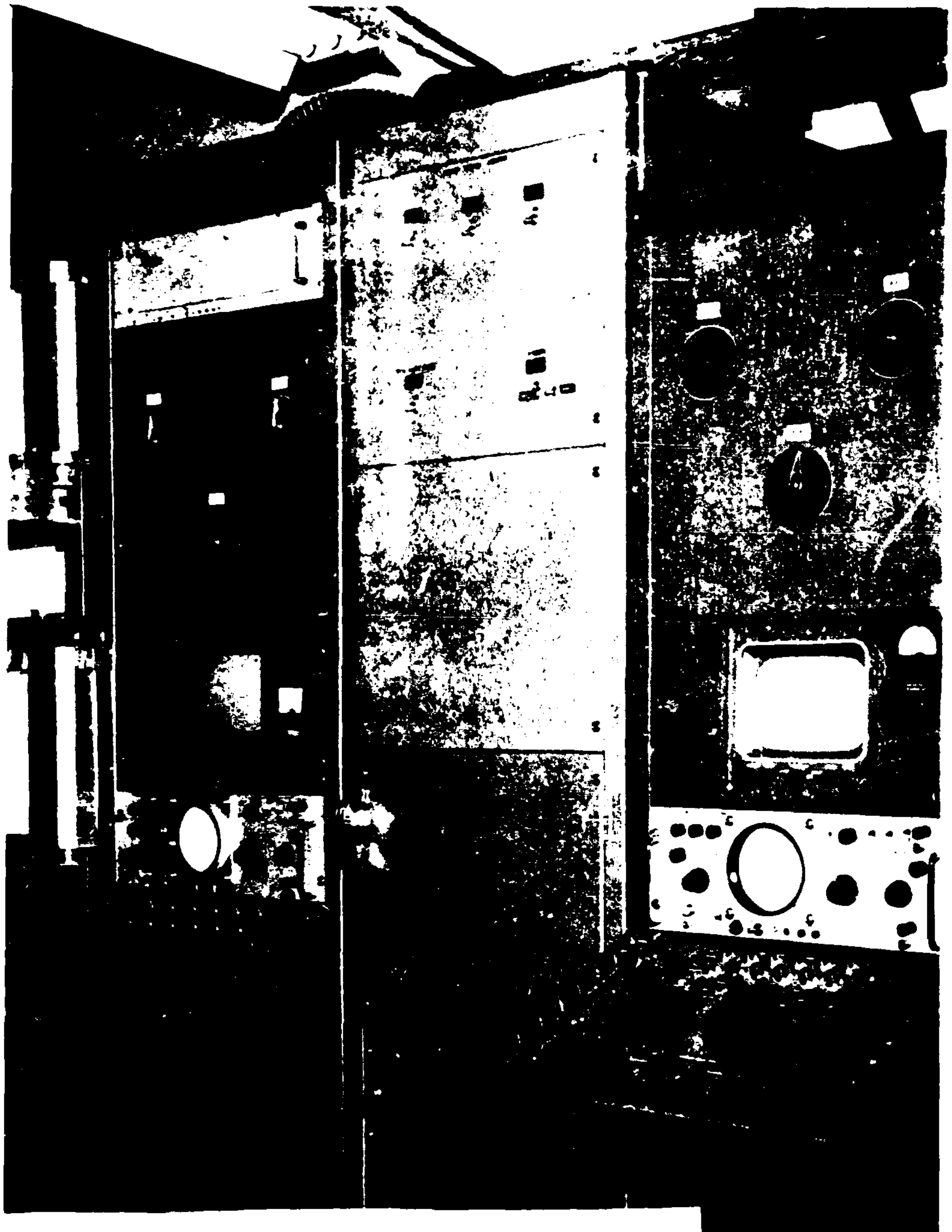

Figure 6. Remote Control Console of Fixed Station System.

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13. ABSTRACT

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